

Abomasal Parasites in Tule Elk (*Cervus elaphus nannodes*) from Grizzly Island, California

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ABSTRACT: Trichostrongylid nematodes were collected from the abomasa of 12 (67%) of 18 tule elk (*Cervus elaphus nannodes*) collected from the Grizzly Island Wildlife Area, California, in August to September 1994; overall mean (± 1 SD) intensity was 44.9 ± 40.0 of abomasal nematodes per host. Three species of nematodes were found: *Ostertagia leptospicularis* and its minor morphotype *Ostertagia kolchida*, *Mazamastrongylus pурсglovei*, and *Trichostrongylus axei*. New geographic and host records are established, respectively, for *O. leptospicularis*/*O. kolchida*, and *M. pурсglovei* in California and for *Cervus elaphus* in North America.

KEY WORDS: tule elk, *Cervus elaphus nannodes*, abomasal nematodes, *Ostertagia leptospicularis*, *Ostertagia kolchida*, *Mazamastrongylus pурсglovei*, *Trichostrongylus axei*.

Among North American cervids, there are numerous studies on geographic distributions of abomasal parasites in several hosts, including white-tailed deer (*Odocoileus virginianus* (Zimmermann)), mule deer (*Odocoileus hemionus* (Raffinesque)) (Walker and Beckland, 1970; Prestwood and Pursglove, 1981), and caribou (*Rangifer tarandus* (Linnaeus)) (Low, 1976; Fruetel and Lankester, 1989). However, little information is available on the occurrence of abomasal parasites in elk (*Cervus elaphus* Linnaeus), including tule elk (*C. elaphus nannodes* Merriam).

Few helminth species have been documented in previous studies of *C. elaphus* in North America, and ostertagiine nematodes rarely have been reported (Lichtenfels and Hoberg, 1993). Boddicker and Huggins (1969) found no abomasal parasites in 20 elk from South Dakota (U.S.A.). Stock and Barrett (1983) found a 5% prevalence of *Trichostrongylus axei* (Cobbold, 1879) among 186 elk from Alberta, Canada. Among tule elk, McCullough (1969) evaluated fecal samples from 50 animals and found single unidentified eggs of a strongylid and ascarid. In contrast, the fauna of *C. elaphus* has been documented extensively in the Palearctic, where it is dominated by ostertagiine nematodes of the genera *Ostertagia* Ransom, 1907, and *Spiculopteragia* Orloff, 1933, and other trichostrongyloid nematodes (Drózdź, 1966; Petrovic et al., 1967; Kutzer and Hinaidy, 1969; Hörning, 1975; Govorka et al., 1988).

Our objective was to document the occurrence, prevalence, and intensity of abomasal

nematodes in the tule elk of the Grizzly Island Wildlife Area, California.

Materials and Methods

Elk for this study were collected during a controlled hunt at the Grizzly Island Wildlife Area (38°09'N, 121°58'W), a 3,450-ha tract of land near the delta of the San Joaquin River, approximately 11 km south of Fairfield, California. Animals initially were examined at a hunter check station, where each abomasum was removed after ligation and frozen at -10°C prior to evaluation.

Each abomasum was evaluated for the recovery of parasites. Following thawing at 20°C , contents were sequentially sieved first through a 9 mesh (1.9 mm) to remove large debris and then through a 100 mesh (150 μm); some smaller parasites, especially larvae, may not have been retained in the 150- μm sieve. Contents retained in the 150- μm sieve were diluted and examined in 10-ml aliquots until 25% of the total volume of the abomasal washings was evaluated. Nematodes were preserved in 70% ethanol and later cleared in glycerine or in phenol alcohol (80 parts melted phenol crystals and 20 parts absolute methanol). Intensity of infection was estimated by multiplying the numbers of actual nematodes recovered $\times 4$ as determined by the 25% aliquots. The female specimens of *Ostertagia* spp. were identified based on the structure of the synlophe (system of longitudinal cuticular ridges) (Lichtenfels and Hoberg, 1993). The 1 specimen of *Trichostrongylus* sp. was assigned to *Trichostrongylus axei* based on comparison to known specimens. Concepts for polymorphism are consistent with Drózdź (1974, 1995) and Lichtenfels and Hoberg (1993).

Because of an unavoidable time lapse between the killing of the elk and the abomasa being collected at the hunter check station, some parasites could have migrated into other organs. Also, use of the 150- μm mesh size may have resulted in the loss of smaller parasites, especially larvae. Thus, the prevalences and

Table 1. Prevalence and intensity of adult abomasal nematodes among 18 tule elk, Grizzly Island Wildlife Area, California, 1994.

Species	No. infected (%)	Intensity		
		Mean	SD	Range
<i>Ostertagia leptospicularis</i> / <i>Ostertagia kolchida</i>	11 (61)	47.9	40.0	12–148
<i>Mazamastrongylus pурсglovei</i>	1 (6)	4	—*	4
<i>Trichostrongylus axei</i>	2 (11)	4	0	4
Total	12 (67)	44.9	40.0	4–148

* Not calculated.

intensities reported should be considered to be minimum values.

Results

Eighteen elk were evaluated during the hunt. Among these, 4 of 6 adult females, 2 of 5 adult males, 0 of 1 male calves, and all 6 yearling males were infected with abomasal nematodes; overall the prevalence was 67% and the mean \pm 1 SD intensity of infection was 44.9 ± 40.0 nematodes per infected host, with an estimated range of 4–148 (Table 1).

Three species were identified: *Ostertagia leptospicularis* Assadov, 1953/*O. kolchida* Popova, 1937, *Mazamastrongylus pурсglovei* (Davidson and Prestwood, 1979), and *Trichostrongylus axei*. Among the 12 infected elk, 8 were hosts for *O. leptospicularis*, 5 also contained the minor morphotype *O. kolchida*, 1 had *M. pурсglovei*, and 2 had *T. axei*. Representative specimens of these nematodes were deposited in the U.S. National Parasite Collection (USNPC), Agricultural Research Service, U.S. Department of Agriculture, Beltsville, Maryland (U.S.A.), as USNPC Nos. 86016.01, 86016.02, 86017, and 86018.

Discussion

The occurrence of *Ostertagia leptospicularis*/*Ostertagia kolchida* and *Mazamastrongylus pурсglovei* at Grizzly Island represents new geographic records for these parasites in California. *Ostertagia leptospicularis*/*O. kolchida* are considered typical parasites of cervids in the Palearctic and Nearctic but have not previously been reported from *Cervus elaphus* in North America (Drózdź, 1967; Hoberg et al., 1993). Currently, these species of *Ostertagia* are considered to represent the major and minor forms of a single polymorphic species (Drózdź, 1995). Additionally, *M. pурсglovei* has not been reported in *C. elaphus*, nor was it known to occur west of Texas

or in hosts other than white-tailed deer (Lichtenfels et al., 1993).

Although occurrence of *O. leptospicularis*/*O. kolchida* in elk is not unexpected (Rickard and Zimmerman, 1986; Mulrooney et al., 1991; Hoberg et al., 1993), the presence of *M. pурсglovei* is enigmatic. The present distribution of the species we report may have been influenced by the specific history of the tule elk now inhabiting Grizzly Island.

The historical range of *C. elaphus nannodes*, endemic to California's Central Valley and delta region (McCullough, 1969), once included Grizzly Island (D. Becker, pers. comm.); tule elk were extirpated from much of this range by 1860 (McCullough, 1969).

There is some information available on the origins of the current tule elk herd at Grizzly Island. The origin of this herd resulted from introductions from 2 locations in California. In 1977, 7 adults came from the Tupman Elk Reserve in Kern County and 1 yearling female came from the Owens Valley in Inyo County, California (Botti and Koch, 1992). Later, an additional adult male was transported from the Fresno Zoo (Fresno, California) to the tule elk herd at the San Luis National Wildlife Refuge; this animal was moved to the tule elk herd at Point Reyes National Seashore (California) in 1978 and finally to Grizzly Island in 1979 (J. Fischer, pers. comm.).

Tule elk at Grizzly Island currently are isolated from other cervid populations, but the elk from Fresno had the potential for co-existence with white-tailed deer, black-tailed deer, and other cervids in a zoo environment prior to introduction on the island. Although *O. leptospicularis* and *O. kolchida* probably occur naturally in other cervid hosts in California (Hoberg et al., 1993), the occurrence of *M. pурсglovei* may have resulted from cross-transmission in the zoo, with

subsequent introduction into the herd at Grizzly Island. Collections of appropriate cervids in California will be required to further evaluate this hypothesis.

Trichostrongylus axei was an uncommon parasite in tule elk but has been reported previously from *Cervus elaphus* in North America (Stock and Barrett, 1983). Additionally, several species of *Trichostrongylus* have been reported from cervids, particularly deer in California (Walker and Becklund, 1970). Domesticated bovids are considered typical hosts for *T. axei*, and this species has a broad host range among ruminants, as summarized by Skrjabin et al. (1954). Although transmission between domesticated stock and wild cervids is often minimal (Pursglove et al., 1976), the nematode could have been acquired from bovids during the complicated history of the elk herd on Grizzly Island.

Abomasal nematodes found in the tule elk did not appear to be pathogenic, but the intensities of infection were very low. Among these species, *O. leptospicularis* has been associated with severe disease and mortality of red deer (*Cervus elaphus*) in Britain (Dunn, 1983).

The relatively low intensity and prevalence of the ostertagiines, particularly *M. pursglovei*, if not an artifact of the methods used in collections, is evidence that these parasites may only recently have been established in the herd at Grizzly Island. This is compatible with the history of known introductions of ostertagiine nematodes associated with the transport of infected cervid hosts in other regions (Hoberg et al., 1993). Such introductions appear to have been relatively common, as indicated by *O. leptospicularis*/*O. kolchida* and species of *Spiculopteragia* in New Zealand and South America (Andrews, 1973; Suarez et al., 1991); *Spiculopteragia* spp. in North America (Rickard et al., 1993); and *O. mossi* Dikmans, 1931, in Eastern Europe (Kotrlá and Kotrly, 1977). The apparent ease with which these ostertagiines become established in new environments and geographic regions is notable. These findings provide additional support for emphasizing the importance of careful parasite surveillance of all animals that may be used in translocations to prevent the unintended spread of potential pathogenic agents to new host species and geographic regions.

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